

CONTRACT REPORT NO. OSQ81-00122

CONCEPTUAL DESIGN OF A
MULTIWIRE ELECTROSLAG CASTING
FACILITY FOR THIN-WALLED CYLINDERS

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MICROMEDIA

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1.0 INTRODUCTION

EMR OTTAWA is putting together a multi-wire electroslag casting facility capable of producing thin-walled cylinders. Davis Engineering received a contract to expeditiously specify key equipment to be used in this installation. Thorough conceptual designs of the various systems were worked out in conjunction with EMR to enable equipment specification. This report primarily covers the following designs: Mould Oscillator, Mandril Extractor, Wire Feeders, and Power Supplies. The other systems such as water cooling, safety, and mould design are already being handled internally by EMR. The list specifying key equipment and suppliers was submitted January 15, 1982; and this report concludes the contract.

2.0 ABSTRACT

2.1 Electroslag Casting

Electroslag casting is a continuous casting technique used to obtain very pure castings, free from inclusions, impurities and bubbles. In slag casting there is an active molten slag layer floating on the cast metal. This slag layer prevents the surface from oxidizing and absorbs any impurities. It also serves as the heat source to melt the casting material which is fed in from above. Electric energy is converted to heat when current is passed through the slag. The electrical resistance of the molten slag gives rise to I^2R thermal power. The casting material is fed into the slag in wire form. This wire also carries the current to the slag thus locally increasing the heat. This effect is useful in stabilizing the process. If the wire is fed too quickly it may not have time to melt and may short to the casting which is grounded through the mould. This tends to extinguish the process since the thermal power generated in the slag resistance drastically reduces during a short. Conversely, if the wire is fed too slowly, the wire melts back increasing the slag resistance and decreasing the power generated which also tends to extinguish the process. The power is reduced with increasing resistance because the process utilizes a constant voltage source on the wire and the power equals the voltage squared divided by the resistance. This constant voltage source plays an important role in stabilizing the process between the two extinguishing conditions. As the wire approaches the casting melt, the resistance in the intervening slag also reduces, thus increasing the V^2/R power quotient. As the wire gets very close to the molten metal this power quotient rises dramatically and the power generation becomes more localized to the slag directly between the wire and the casting. This increase in local power tends to melt the wire more quickly so the mechanism tends to self regulate, i.e., the melt rate will increase to

the wire feed rate by reducing the distance between the wire and the top of the casting. In this way the constant voltage supply allows some leeway in wire feed rate while still maintaining a stable process.

2.2 Electroslag Process Startup

Several techniques have been proposed to initiate an electroslag process. One is to inject molten slag and start all systems simultaneously at the steady state casting rate. This technique requires more complex mould design to facilitate the slag injection, not to mention the extra equipment needed. The other main technique starts up by arcing to a mixture of metal filings and powdered slag distributed at the bottom of the mould. The voltage, wire feed rate and oscillation rate should be reduced until the arcing is extinguished by molten slag. The electroslag process depends on the slag being molten because solid slag does not conduct electricity. In multiwire systems both techniques become difficult to synchronize, especially the cold start; and the molten slag injection system would also increase in complexity.

2.3 Thin-Walled Electroslag Casting

Casting thin-walled sections between water cooled moulds imposes several more problems on the electroslag process. The rapid cooling provided by the water causes a grain structure in the finished casting which is dependent on proximity to the wire feed point. This problem can be minimized by placing multiple wire feeds close to each other and/or oscillating the wire with respect to the casting. The optimal oscillation rate is a trade-off between casting uniformity and process stability since faster oscillation improves uniformity but reduces stability. The stability is decreased in two ways: extreme speeds will cause splashing; arcing and shorting; and the heat generated in the slag directly below the wire is less localized as the speed increases. Another problem with thin walled castings is that

the wire must be fed between the mould walls without arcing or shorting. This problem can be alleviated by using rigid consumable tubes to guide the wire down. These guide tubes must also be insulated from the mould walls with insulating standoff washers.

2.4 Cylindrical Casting

Casting thin-walled cylinders presents the further problem of trying to prevent the inner mould or mandril from being frozen into the casting. One solution is to withdraw the mandril as the casting progresses, insuring that the rate is slow enough to prevent molten material from flowing under the mandril into the casting hollow. With this technique, it is important to determine how deeply the mandril extends into the frozen portion of the casting. A crude indication of this depth is the force required to withdraw the mandril. As the casting solidifies and cools, it will contract about the mandril so the deeper the mandril is the more force is required to withdraw it. This implies that the extraction rate should be proportional to the extraction force; as the mandril gets too deep, the extraction force increases, and the extraction rate should be increased; as the mandril gets too shallow, the extraction force decreases, and the extraction rate should also be decreased. This solution requires a control system which uses force feedback. Another solution is to design some sort of collapsible mandril which can be evenly water cooled yet may be disassembled from within once the casting is complete.

3.0 GENERAL SYSTEM DESCRIPTION (See Fig. 1)

The initial electroslag casting system will be used to produce hollow cylindrical steel tubes up to three feet long with a wall thickness of one to two inches and an inside diameter of eight to twelve inches. This electroslag continuous casting process requires metal to be melted into the mould from above while the lower portions are cooling and freezing at a steady rate. The metal will be supplied in wire form from four constant rate wire-feeders; one in each quadrant of the casting. The wire will be melted by a molten slag annulus which will float on the molten metal and casting. The slag also serves to eliminate impurities, oxides and inclusions from the casting. The slag will be heated resistively by current flowing through it from the four wires to the grounded mould. Each wire will be guided between the mould walls by a consumable guide tube which will also transfer the current from one of four constant potential A.C. welding supplies to the wire. The guide tubes will have consumable insulating washers every six inches to prevent the guide from arcing or shorting to the mould. In order to maintain the molten slag and metal as a continuous liquid ring, the mould will be oscillated through a 90° arc. To prevent the inner mould or mandril from becoming stuck in the casting it will be withdrawn as the casting progresses, but not to the extent where it gets high enough for liquid to flow underneath it. The mandril will be guided up by a grooved concentric shaft, which will be fixed to the oscillating base, so that a corresponding key on the mandril will force it to oscillate with the shaft. The mandril will be raised by a D.C. motor/linear actuator combination, controlled by the extraction force. As the withdrawal force decreases, so will

the withdrawal rate, thus keeping the mandril partly in the frozen (contracting) metal. The mandril, the outer mould and the base plate will all be water cooled through flexible hoses. The outer mould and base plate are fixed to an oscillating dias which will be anchored to the floor through a torsion eliminator, so that the mandril doesn't lift everything with it. In order for the finished casting to be a very brittle alloy, the wire will either be of the same composition or it will have to be cored with the alloying materials. Initially mild steel will be used as a casting material.

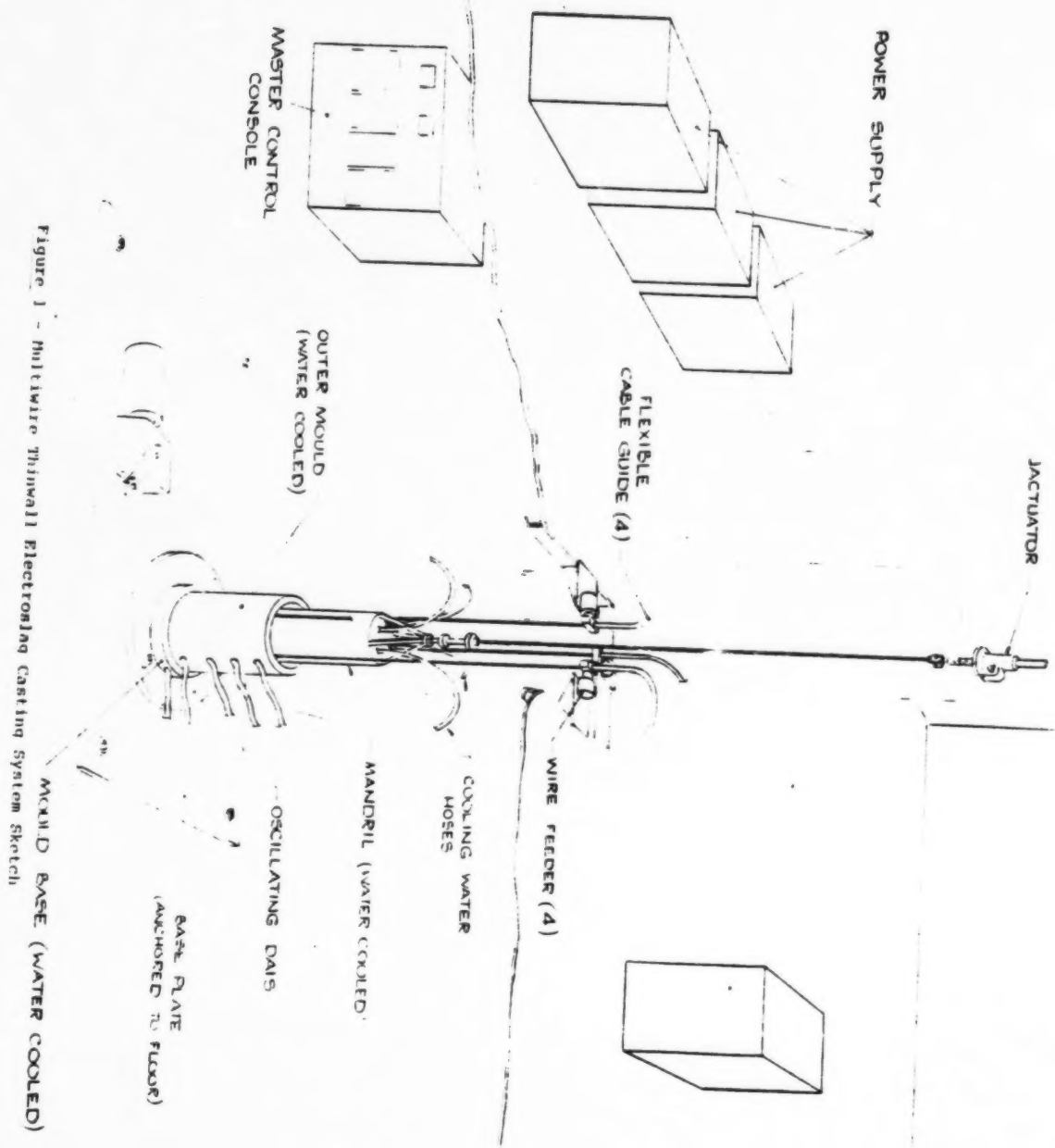


Figure 1 - Multewire Thinwall Electromagnetic Casting System Sketch

4.0 PROCESS CONTROL SYSTEMS

There are 5 distinct control systems contributing to this casting process. These are:

1. Cooling System
2. Mould Oscillator System
3. Mandril Extraction System
4. Wire Feed System
5. Power Supply System

4.1 Water Cooling System

Both the mandril and the outer mould are water cooled. This cooling controls the rate at which the molten metal freezes, directly affecting the finished grain structure. There are also important constraints on the water flow rate just to keep the process stable. At one end the flow rate must be high enough to prevent the water from boiling or the slag from melting the moulds. At the other end the flow rate must be low enough so that the molten metal can exist very close to the mould walls and even so that the process doesn't extinguish. Most of the energy supplied by the welders must be transported away in the water in a steady state fashion, so initially there will be manually adjusted valves to control the water flow rate. There will be a full complement of temperature probes to monitor the performance of this system.

4.2 Mould Oscillation System

The mould oscillator has only one function, that being to maintain an even distribution of power input around the cylinder so that the slag and metal will form a continuous molten annulus at the current top of the casting. The

oscillator will consist of a D.C. motor with manual speed control, geared down through a reducer, driving a piston type linkage attached to the edge of the casting's base plate. The D.C. motor controller will be manually adjusted to the optimum speed; fast enough to maintain a continuous molten ring, slow enough to prevent splashing and arcing.

4.3 Mandril Extraction System

The mandril must be extracted as the casting progresses to prevent it from being frozen into the finished casting; yet it is desirable to keep the lower section of the mandril in the frozen portion of the casting so that the liquid doesn't leak into the center of the cylinder. Since there is no direct method of determining where the solid/molten interface is, it must be deduced from other parameters such as temperature gradients or extraction force. As the casting freezes and cools, it tends to contract in on the mandril so the further the mandril is into the frozen portion of the casting the more force is required to extract it. This implies that the extraction rate should be directly proportional to the extraction force (i.e., if the force increases, implying that the mandril is too deep, the extraction rate should increase). The extraction apparatus will consist of a D.C. motor and controller driving a linear actuator through a reducing gear. The actuator will be connected to the mandril from above through a load cell and a torsion eliminator. The load cell signal which indicates extraction force will be monitored, conditioned and fed back to the D.C. motor controller to govern the extraction rate. The torsion eliminator is necessary to prevent up and down movement which would result if the vertical actuator were allowed to oscillate with the mandril. Another reason for the torsion eliminator is that the load cell cannot withstand high torsional loading.

4.4 Wire Feed Systems

There will be four wire feeding systems which must be synchronized to feed wire at the same rate. This is to insure the casting progresses evenly and that no wire feeder runs out of wire before the casting is complete. All four wire feeders will be manually adjusted to feed wire at the same constant rate. The feed rate must be slow enough so that the wire melts before it causes a short to the casting yet fast enough to keep the process alive.

4.5 Power Supply Systems

There are 4 square wave A.C. welders supplying power to the melt through the 4 feeding wires. These power supplies will be operated at a constant potential. The power is converted to heat due to the resistance of the slag as the current flows between the wires and the grounded moulds. As the wires get closer to the cast metal, the slag resistance decreases. This causes an increase in power as heat, since power equals the voltage squared divided by the resistance, and the voltage is constant. The increase in heat will tend to melt the wire back more quickly, thus preventing the wire from extending all the way down and shorting to the casting. This effect will tend to keep the wire at a stable distance from the molten metal. The supply voltage will be manually set to optimize wire feed rate. The optimum rates for water flow, oscillation mandril extraction and wire feed, as well as voltage will be determined experimentally. The initial tuning, as well as normal operation, will be aided by displays monitoring such parameters as water temperatures, mandril position, extraction force, voltages and currents, etc.

5.0 MANDRIL DESIGN

5.1 Background

The basic attribute of the ESR process over a statically cast ingot is the high degree of control which can be exercised over freezing parameters. The control of heat flow directly affects the thermal gradient and growth rate of a freezing alloy. Mould wall thermal properties can best be rationalized as heat input (Q_i) and heat abstracted (Q_a). It can be shown that Q_i is composed of the heat required to melt the electrode, energy to superheat the metal droplets, and heat transferred across the slag/metal interface by the molten droplets. The Q_a term involves the heat lost by radiation from the slag surface, heat lost to the mould cooling water across the slag cap, heat lost to the mould cooling water by the alloy pool, heat lost to the mould cooling water by the solidified ingot, heat lost to the base plate cooling water and the heat retained by the ingot when it is stripped. These latter terms are shown in Figure 12.1.

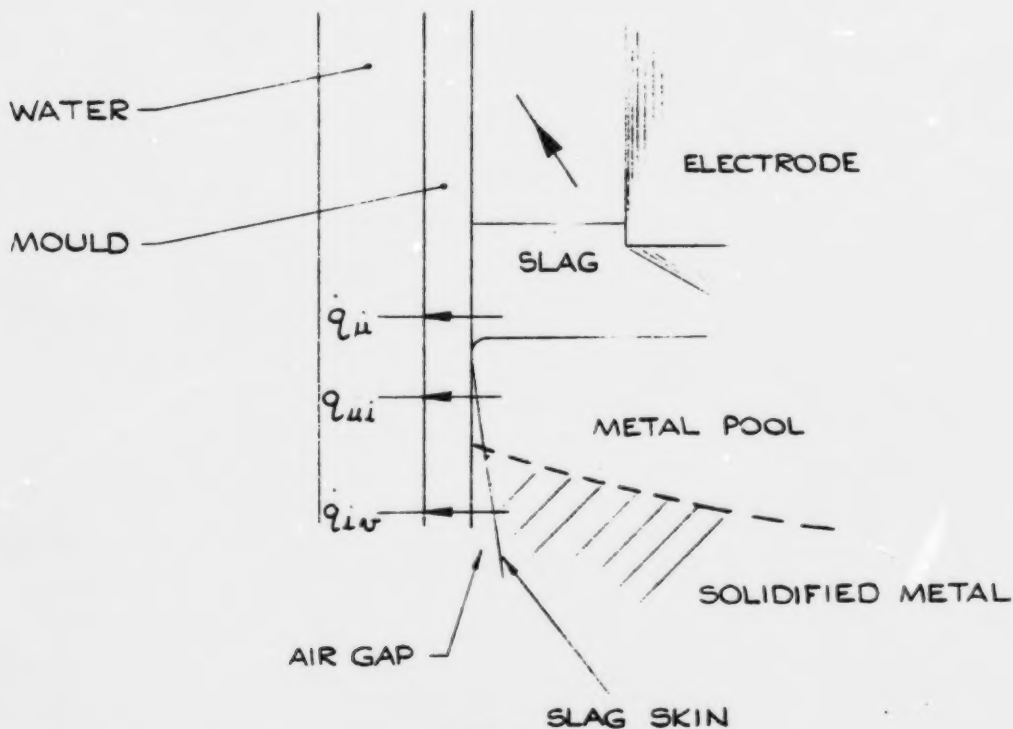


Figure 12.1

Approximately 30 - 50% of the total power generated in an ESR slag passes directly to the mould in the slag region. Indirectly, over 70% of the total heat generated passes into the mould cooling circuit in a moving-crucible configuration. The distribution of heat flux is normally symmetrical in a radial of horizontal plane, but is far from uniform in an axial direction. Figure 12.2 details the typical heat transfer in a hollow ingot ESR furnace. As indicated, the mould heat flux shows a steady decrease below an abrupt maximum reached at a position radially opposite the electrode tip region.

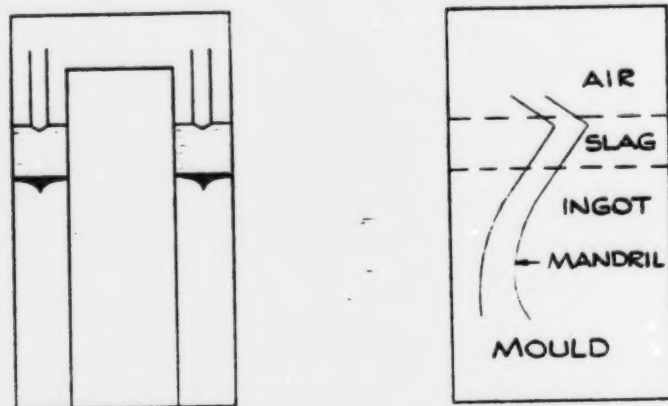


Figure 12.2

5.2 Mould Design Requirements

The following is a list of the major mould design requirements.

- 1) Should be capable of removing up to $40 \frac{\text{cal}}{\text{cm}^2\text{s}}$ from a process region of up to 5 cm in depth.
- 2) Should be capable of removing up to 80% of the total process heat at any given time.
- 3) Non-boiling systems ONLY should be used. These are intended to be operated close to the initiation point for Nucleate boiling on the mould/water interface. They have the advantage of increased creep resistance of the mould (from lower overall wall temperatures) and the ability to accommodate both transient high-heat flows and perturbations in the local condition of the mould/water interface.
- 4) {From point (3)} Surface - water velocities of between 3 - 6 cm/sec are required to keep the water from boiling.
- 5) Should be designed as a flexible body which can contain the ingot to close and finite dimension and allow for expansion and contraction.
- 6) Should have a certain amount of taper.

5.3 Mould Design Considerations

5.3.1 Structural

- 1) Must be flexible to allow for expansion & contraction.
- 2) Must be rigid enough to contain the ingot to close dimensions.
- 3) Copper liner must be supported.
- 4) Copper wall thickness should be less than 2".
- 5) Copper must be able to move in horizontal and vertical planes but restricted in the axial plane.

5.3.2 Cooling Water

- 1) Can be throughput, or recycled.
- 2) Must be free of minerals (prevent scale buildup).
- 3) Should keep high temp region of mould at near boiling condition.
- 4) Water pressure should be minimal to reduce hydrostatic stresses.
- 5) Water velocities should be high enough to keep water in a near boiling condition (3 - 6 cm/sec).
- 6) Must be maintained up to and during ingot stripping.
- 7) Bulk Temperature is generally about 25°C.

5.3.3 Liner

- 1) Can be made from pure copper or an alloy or alluminum.
- 2) Should not be greater than 2" thick (minimize thermal distortion).
- 3) Should allow for movement in horizontal and vertical planes but not in axial.
- 4) Can be removeable for cleaning purposes (not essential).
- 5) Must be supported.

5.3.4 Base Plate

- 1) Must support the ingot and mould.
- 2) Must provide a return current connection from the base of the ingot.
- 3) Generally copper plate located on a water-cooled steel tank.
- 4) Water passage guides can be spiral to improve heat extraction.
- 5) Top copper plate surface should be smooth, flat and clean at all times.
- 6) Thickness varies from $\frac{1}{2}$ " - $1\frac{1}{2}$ " copper plate.
- 7) Can be protected with a mild steel plate.

6.0 ELECTRO-MECHANICAL DESIGN

6.1 Oscillator Systems (See Figure 2)

The optimum oscillation rate is not known but a flexible design can be implemented by choosing generous limits and allowing the rate to be adjustable over the entire range. Another unknown is the exact torque which will be required to maintain a steady oscillation. The 1/6 H.P. D.C. motor chosen has a nominal maximum speed of 1750 RPM. To convert this to a maximum oscillation rate of 70 cycles per ^{minute}~~second~~ requires a gear ratio of 25 to 1, which can be accomplished with a single reduction worm gear. A simple D.C. controller allows the motor speed to be adjusted between 60 and 1750 RPM, providing an oscillation rate anywhere between 25 seconds per cycle and 0.86 seconds per cycle. The torque required is determined by several factors.

- a) The momentum of the mould, mandril, base plate and casting as they reverse.
- b) The stiffness of the various water hoses.
- c) The bearing friction in the mount and torsion eliminator.
- d) The viscous drag on the 4 wire feeds.

The motor and reducer combination can exert about 12 ft. lbs. of torque on the crank. Since the load (or force in the connecting rod) is roughly cosinusoidal and the component of this which counters the motor torque is roughly sinusoidal, the crank torque required to maintain a constant crank speed is a $\sin \times \cos$ function of crank angle. This implies that the maximum crank torque occurs when the crank is approximately 45° from being in line with the connecting rod. At this angle, with a crank torque of 12 ft. lbs., the connecting rod will apply about 43 ft. lbs. of torque to the mould assembly. The maximum force in the connecting rod occurs when it is in line with the crank (end of stroke) but this force is supplied primarily by the reducer

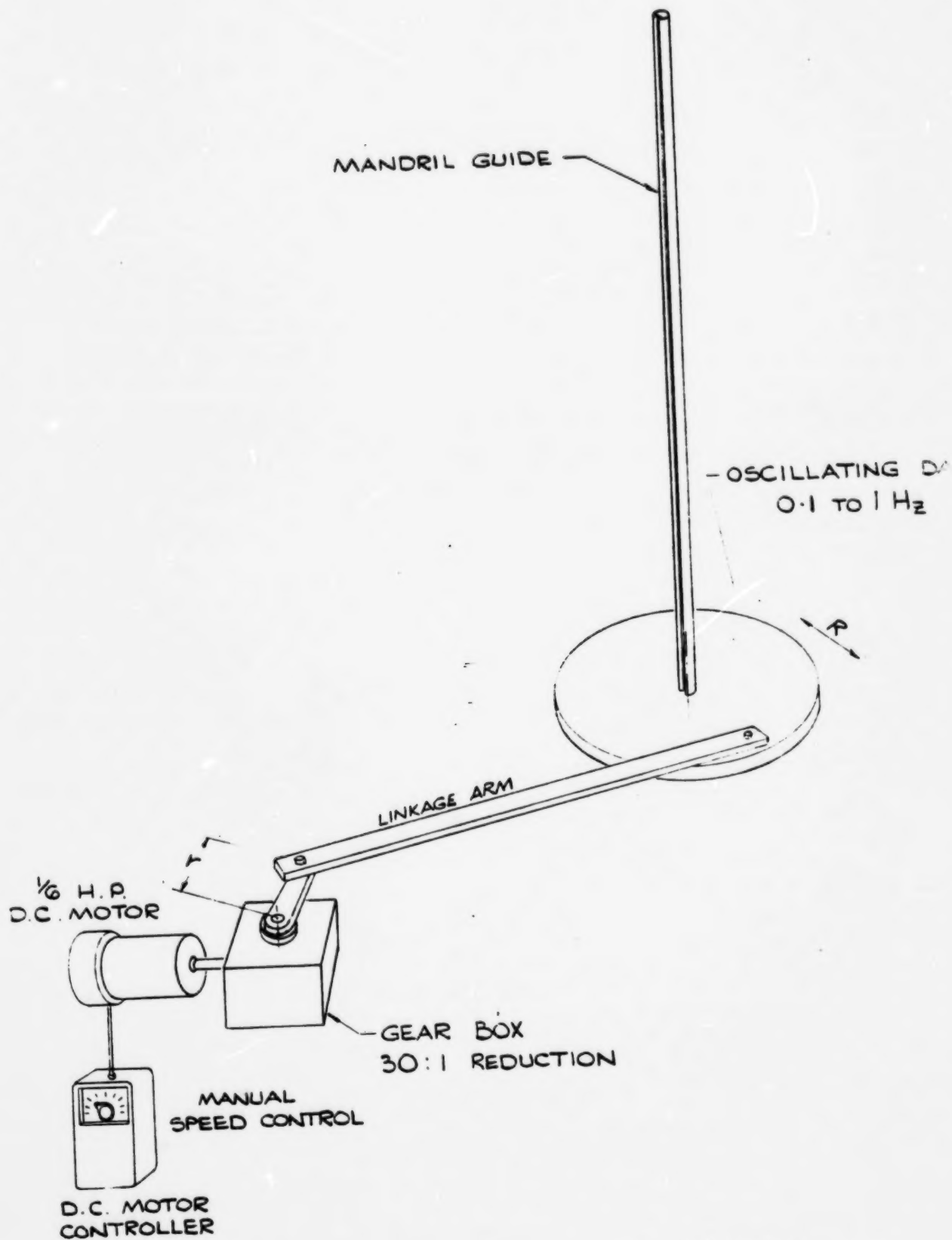


Figure 2 - Mould Oscillator System Sketch

bearings, not the crank. In this position the mould receives about 60 ft. lbs. of torque. This configuration should have enough torque to oscillate a 75 lb. mould assembly once per second or larger moulds at lower speeds. Another technique to allow larger moulds and to even out the fluctuating load is to add a flywheel to the motor. The torque load from the hoses, bearings, and viscosity should only be a few ft. lbs.

6.2 Extraction System (See Figure 3)

The extraction rate of the mandril must roughly equal the casting rate which is specified to be between one and three feet per hour. It is desirable to operate the D.C. motor near its rated speed of 1750 RPM although the motor controller can control the speed over a 30:1 range. The same 1/6 H.P. D.C. motor type and 25:1 reducer may be used for this application giving a maximum intermediate output of 70 RPM. A jactuator with a ratio of 96 turns per inch converts 70 RPM to 3.6 feet per hour. A more flexible ratio might be 24 turns per inch which would allow a maximum of 3 ft. of raise in 12.3 min. and a minimum controllabl speed of .5 ft. per hour but might require the motor to operate at low speed for long periods of time. Either combination is capable of lifting 2 tons so the mould and base plate should be anchored down through a bearing which allows free rotation. The motor controller has an external demand input which is fed from the amplified load cell signal. The load cell force is also displayed as kilograms of lift. The load cell itself has a 1.5 ton capacity but can withstand over 2 tons without damage. There is also an accessory pot mounted on the jactuator to indicate position via a digital display. Because of the large gear ratio, resetting the jack by reversing the motor will be a tedious affair. It will probably be quicker to disconnect the jack and run it down with a hand drill.

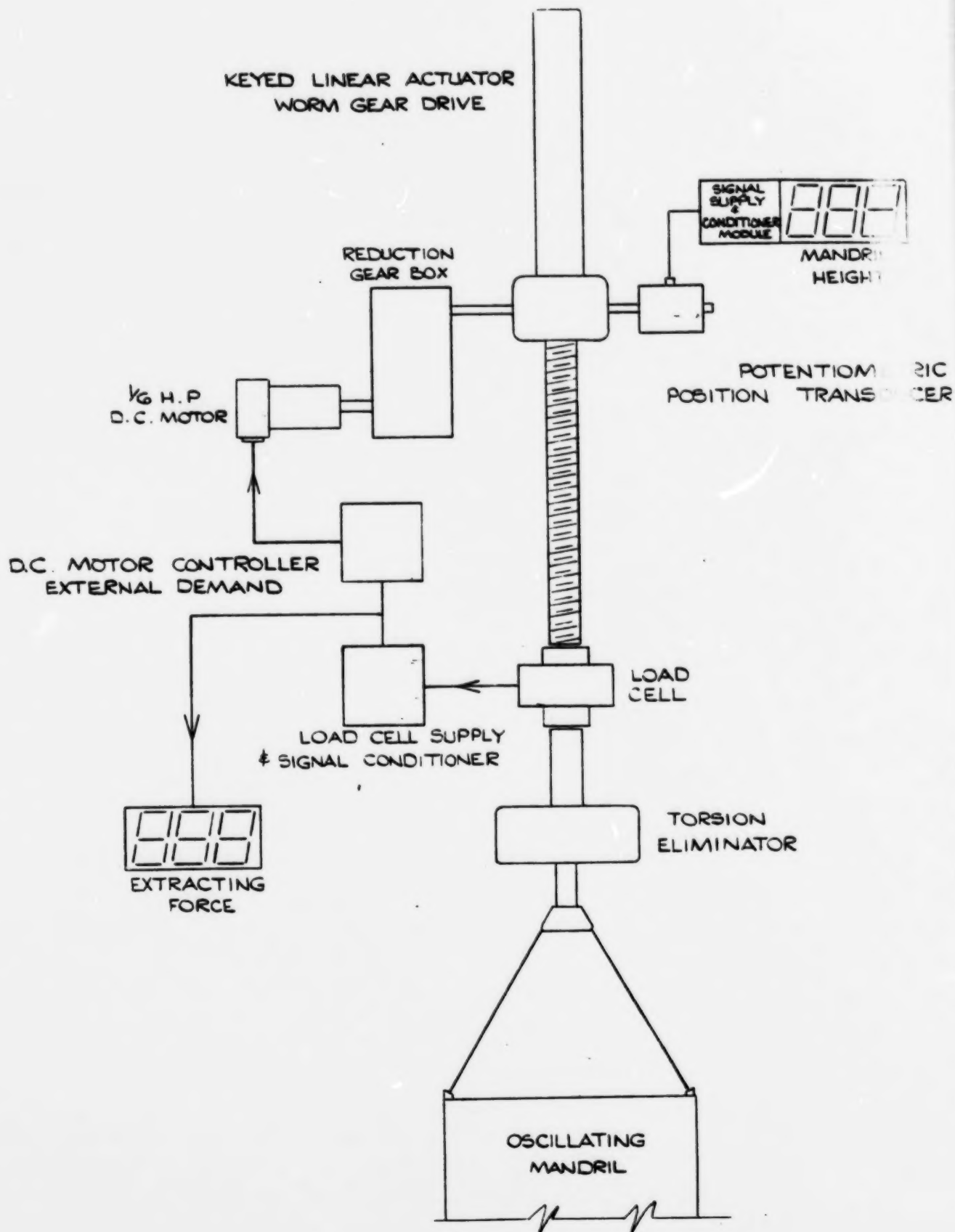


Figure 3 - Mandril Extraction System Sketch

6.3 Wire Feed Systems (See Figure 4)

The wire feeders should be mounted as close to straight above the mould as possible because they are fitted with wire straightners and letting the wire bend downstream only defeats the purpose. This will interfere with the extraction system mounts. A tradeoff will have to accommodate the wire lead in alignment and the jack mounts. Another space problem will be feeding the hoses between the wire guides to the mandril. Since the mandril and hoses rotate 90° with respect to the wire guides and the wire guides are 90° apart, the hoses must be clamped or fed through fenders. If the hoses bump the wire guides it could cause arcing to the mould. In order to obtain a full 90° rotation it is necessary to have the hoses flexing in the space between the wire guides and the mandril, consequently the hoses should extend up a foot before being brought out between the guide fenders.

6.4 Power Supply Systems

The voltage of all four welders should always be the same as should the four wire feed rates. The wire feeders have provisions to control the welder voltage, but since each welder probably has slightly different control characteristics, one controller cannot easily make all four welders produce the same voltage especially since the voltage is reduced during startup. If each automatic wire feeder voltage controller is connected to one welder then each welder-wire feeder pair can be manually calibrated to the same time vs. voltage characteristic for startup and continuous operation. Although the most flexible configuration utilizes four separate power systems, if the constant voltage technique proves successful, later versions would only need a single power supply and controller to supply all wires with the same voltage. The various mounts for wire reels, wire feeders, and wire guides must be electrically insulating because the wire voltage appears on all of them.

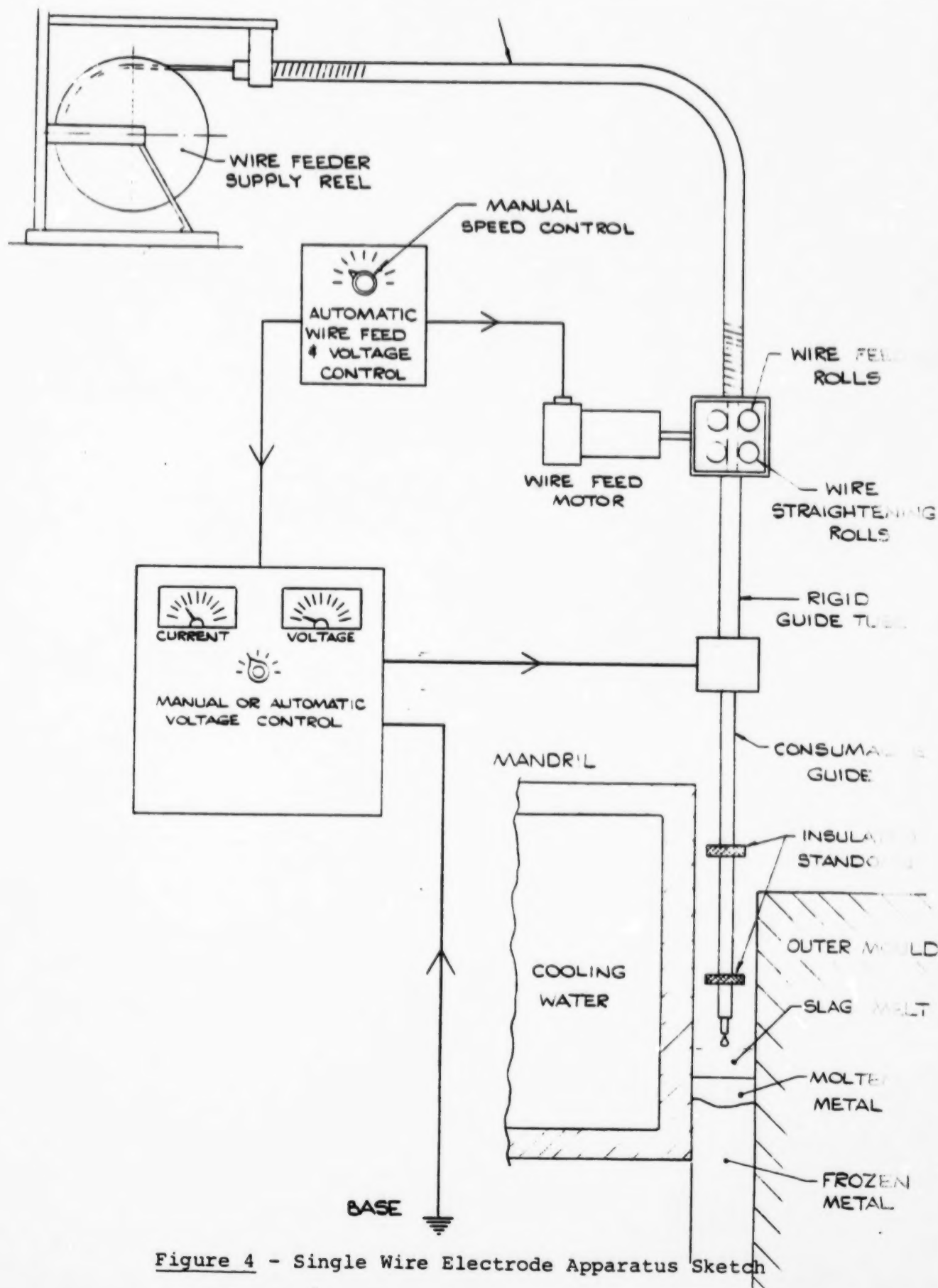


Figure 4 - Single Wire Electrode Apparatus Sketch

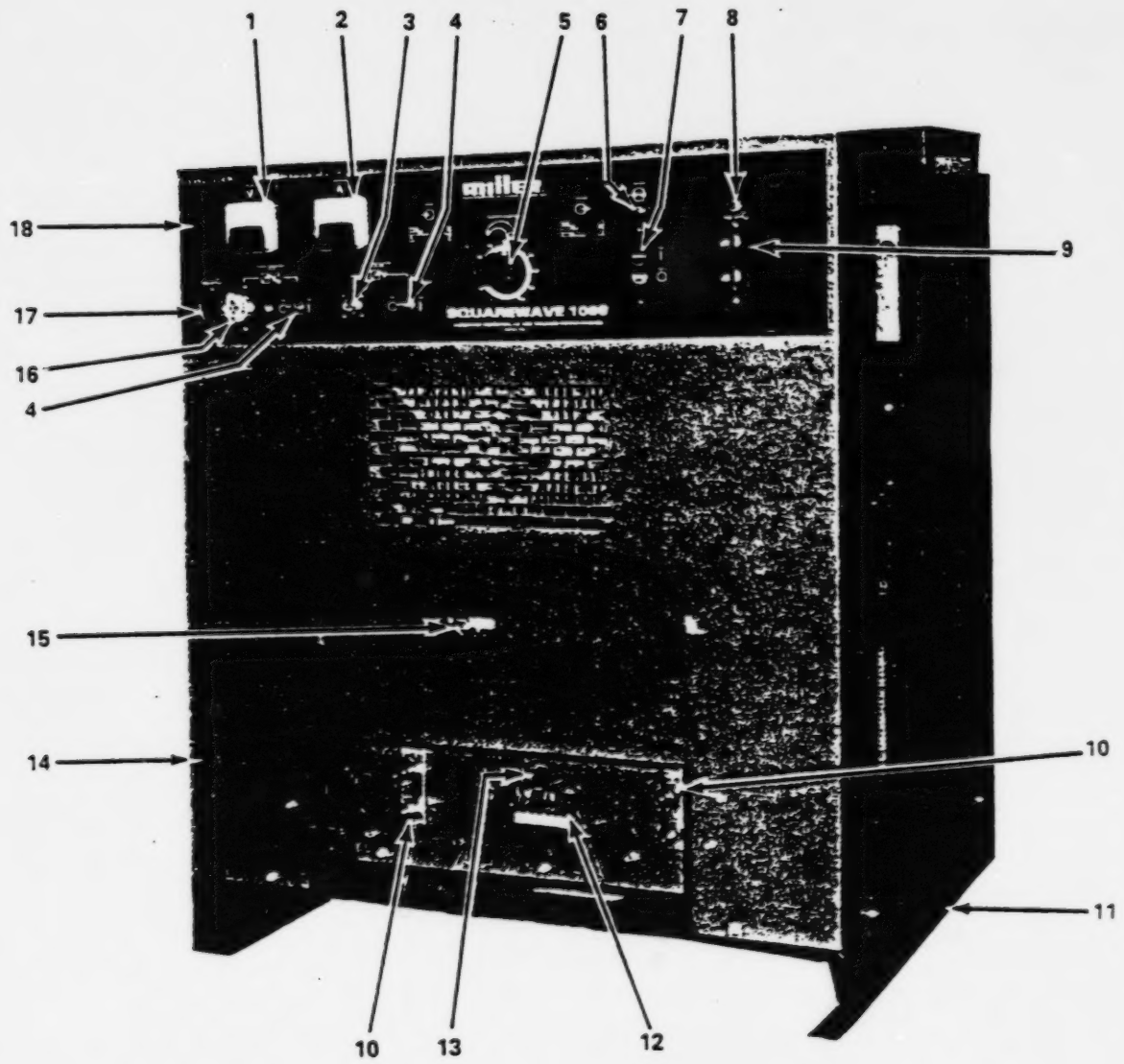
All of the controls and monitors in the system should be safely and easily accessible on a main console to permit easier calibration, operation and emergency shutdown. The following parameters will have to be juggled experimentally in order to obtain a workable process.

- a) Water flow rates - Initially set to maximum then reduced until the onset of boiling on mandril creep.
- b) Amplification of the Load Cell Signal Feeding the Mandril Extraction Controller - Initially set minimum motor speed (60 RPM) from a load cell signal equal to the mandril weight. Set maximum motor speed (1750 RPM) to occur when the force reaches 50% of the allowable limit. If the force ever reaches 50% the welders and wire feeders should be shut down while the mandril is extracted at full speed. Then the load cell signal gain should be increased to reduce the force at which the motor reaches full speed. However, further trials should still use 50% as the shut down force. If possible the casting rate or gear ratio should be adjusted to maintain a stable withdrawal with the motor running above 60% of its rated speed. Note that the extraction system should not be started until the casting is well under way. The exact delay will depend on the casting rate. There should be a force transient as the mandril initially breaks away from the casting. The outer mould should have a lip to insure that the casting doesn't ride up with the mandril.
- c) Wire Feed Rates - Initially set to a minimal rate and manually synchronized to feed at the same rate both on startup and during continuous casting. The speed should be increased to obtain a maximum casting rate as experience is gained with the effects of the various parameters on the process.

- d) Voltage - Initially set fairly low to determine its effect on the process. It will have to increase as the casting rate is increased. Voltages should be synchronized after each change.
- e) Oscillation Rate - The mould oscillator should be controlled manually, starting slowly only after the first startup arc. Once up to continuous casting voltages the oscillation rate should be set to the minimum rate required to maintain a continuous molten slag annulus around the mandril.

- 1) Set up a single electrode non-oscillating process for casting solid cylinders to accumulate data on the interaction of voltage, wire feed rate, slag depth, and wall thickness. Also to provide insight on startup techniques.
- 2) Set up a two or more electrode non-oscillating process varying the electrode spacing and wall proximity. Again determining optimum parameter values.
- 3) Add oscillation of the mould and experiment with different rates; first with one then with more electrodes.
- 4) Add the mandril apparatus and anchor the oscillator.
- 5) Vary the wall thickness and the wire composition.

At this stage manual control of the process should be feasible and the knowledge gained could be used to minimize the equipment needed for future versions. The various parameter interactions should also be well enough characterized to optimize the control system and consolidate it under the control of a single automatic master controller.



- Front View

Figure 5 - Power Supply Photograph

Item No.	Dia. Mkgs.	Part No.	Description	Quantity
Figure Front View				
1	V	025 645	METER, volts ac 0-100	1
2	A	071 234	METER, amp ac 50MV 0-1.5K	1
3	RC2	035 523	RECEPTACLE, 5 socket MS-3102A-16S-8S	1
	C20,21, 24,25	031 670	CAPACITOR, ceramic 0.05 uf 500 volts dc	4
4	S2,11	011 609	SWITCH, toggle SPDT 15 amp 125 volts	2
5	R1	035 897	POTENTIOMETER, carbon 1 turn 2 watt 1000 ohm	1
		Special	BRAKE, potentiometer	1
		019 609	KNOB, pointer	1
6	PL1	*027 645	LIGHT, indicator - red lens 125 volts ac	1
7	PB1	011 636	SWITCH, push button 10 amp 550 volts ac	1
8	CB1	020 278	SWITCH, circuit breaker 15 amp	1
9	RC1	604 176	RECEPTACLE, straight - duplex grounded 2P3W	1
	C4	007 967	CAPACITOR, metalized paper 1 x 1 uf 115 volts ac	1
10		038 612	TERMINAL, power output (consisting of)	2
		038 613	TERMINAL BOARD	1
		038 900	STUD, 1/2-13 x 2-1/4	2
		601 840	NUT, hex - jam 1/2-13	4
		601 839	NUT, hex - full 1/2-13	2
		038 847	BUS BAR	1
		602 247	WASHER, flat - SAE 1/2	2
		605 787	WASHER, lock - internal tooth 1/2	2
	C22,23	006 034	CAPACITOR, ceramic 0.003 uf 3000 volts	2
		072 266	BRACKET, mounting - terminal assembly	1
11		072 272	BASE	1
12	1T	038 772	BLOCK, terminal 20 amp 6 pole	1
13		010 493	BUSHING, snap 5/8 ID x 7/8 mounting hole	1
14		072 381	PANEL, front	1
15		605 583	CATCH, spring - loaded door	1
16	RC5	039 634	RECEPTACLE, twistlock - flanged 2P2W 20 amp 250 volts	1
		039 635	CONNECTOR BODY, twistlock 2P2W 20 amp 250 volts	1
17	RC6	039 686	RECEPTACLE, twistlock - grounded 2P2W 15 amp 277 volts	1
18			NAMEPLATE (order by model & serial numbers)	1

*Recommended Spare Parts.

BE SURE TO PROVIDE MODEL AND SERIAL NUMBERS WHEN ORDERING REPLACEMENT PARTS.

Figure 6 - Power Supply Parts List

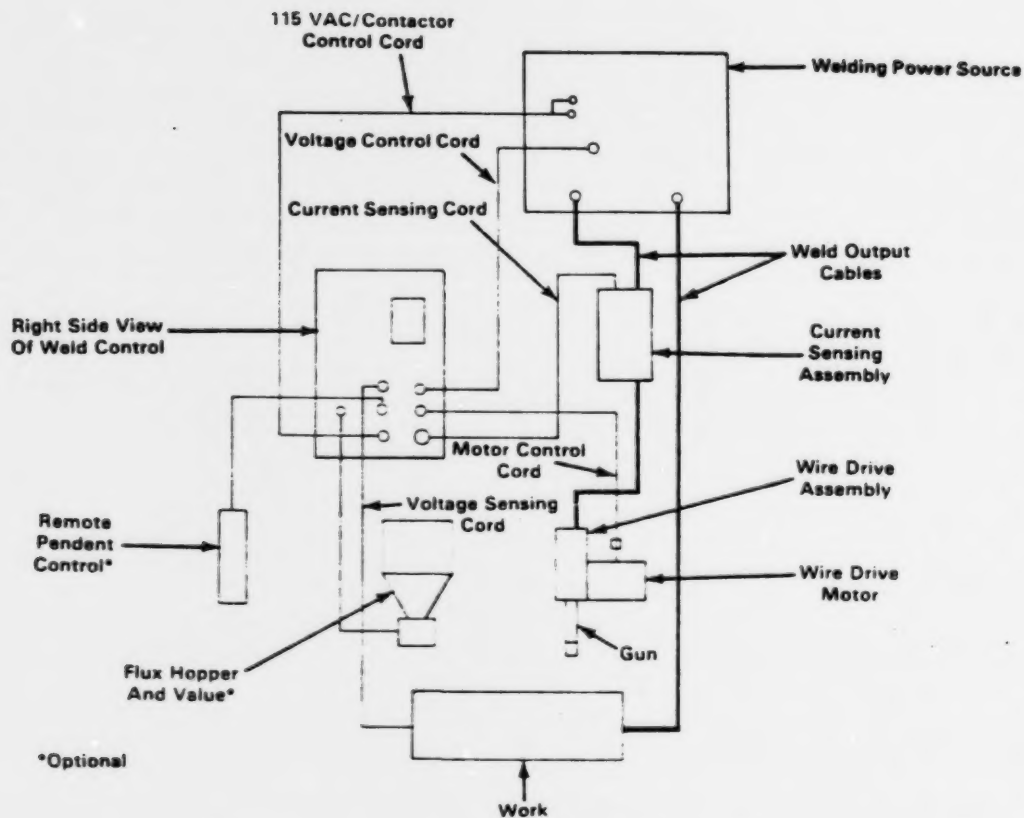


Figure 7 - Controller Connections

- OPERATOR CONTROLS

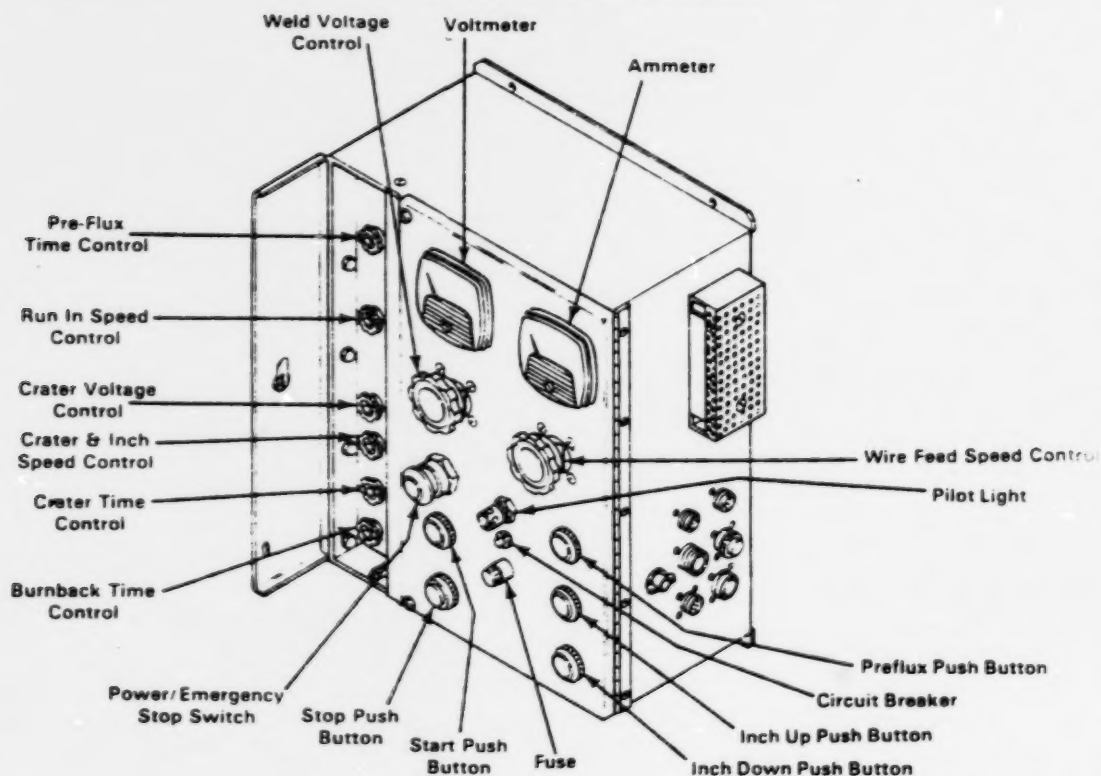
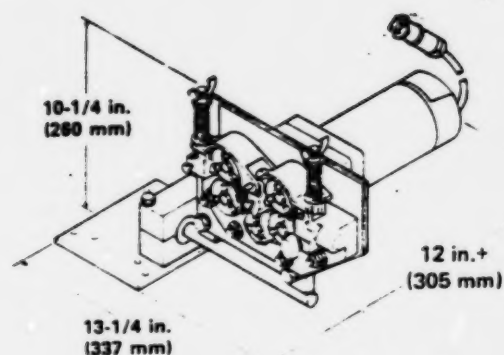
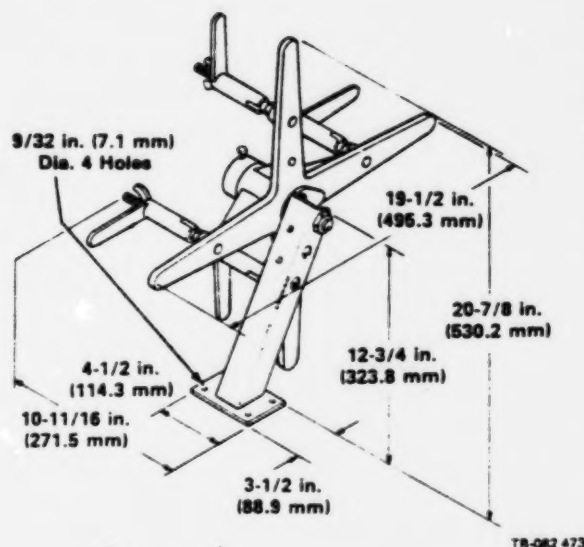
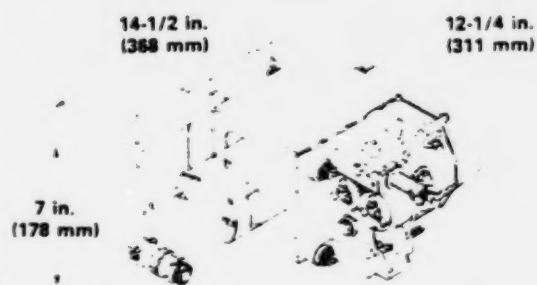
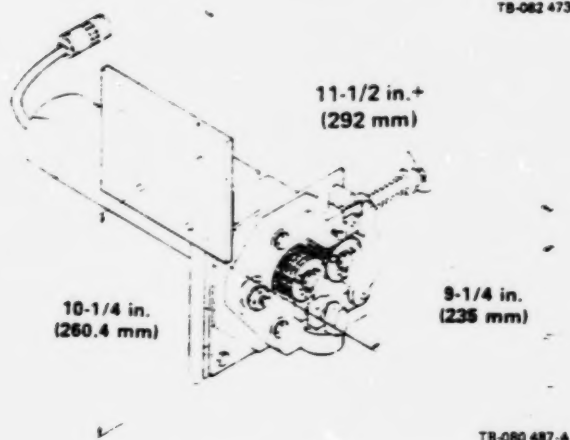


Figure 8 - Controller Diagram

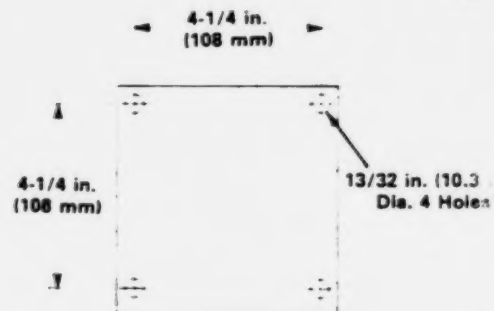
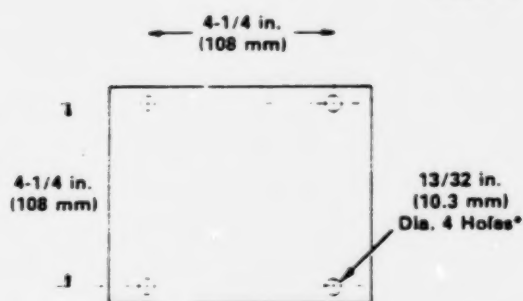


+Add 7/8 in. (22.2 mm) for D Models

TC-070 001



TC-081



*Holes shown can be used when mounting to optional cross slide. Additional holes are provided that can be used when mounting to weld oscillator (A1 Models).

*Holes shown can be used when mounting to optional cross slide. An adapter must be used when mounting to weld oscillator (A2 Models).

Overall Dimensions And Mounting Hole Layout

Figure 9 - Wire Feeder Diagram

DUFF-NORTON 1800 SERIES MACHINE SCREW JACTUATOR[®] MODELS

Capacities from $\frac{1}{4}$ Ton to 250 Tons
Worm Gear Ratios from 5:1 to 36:1

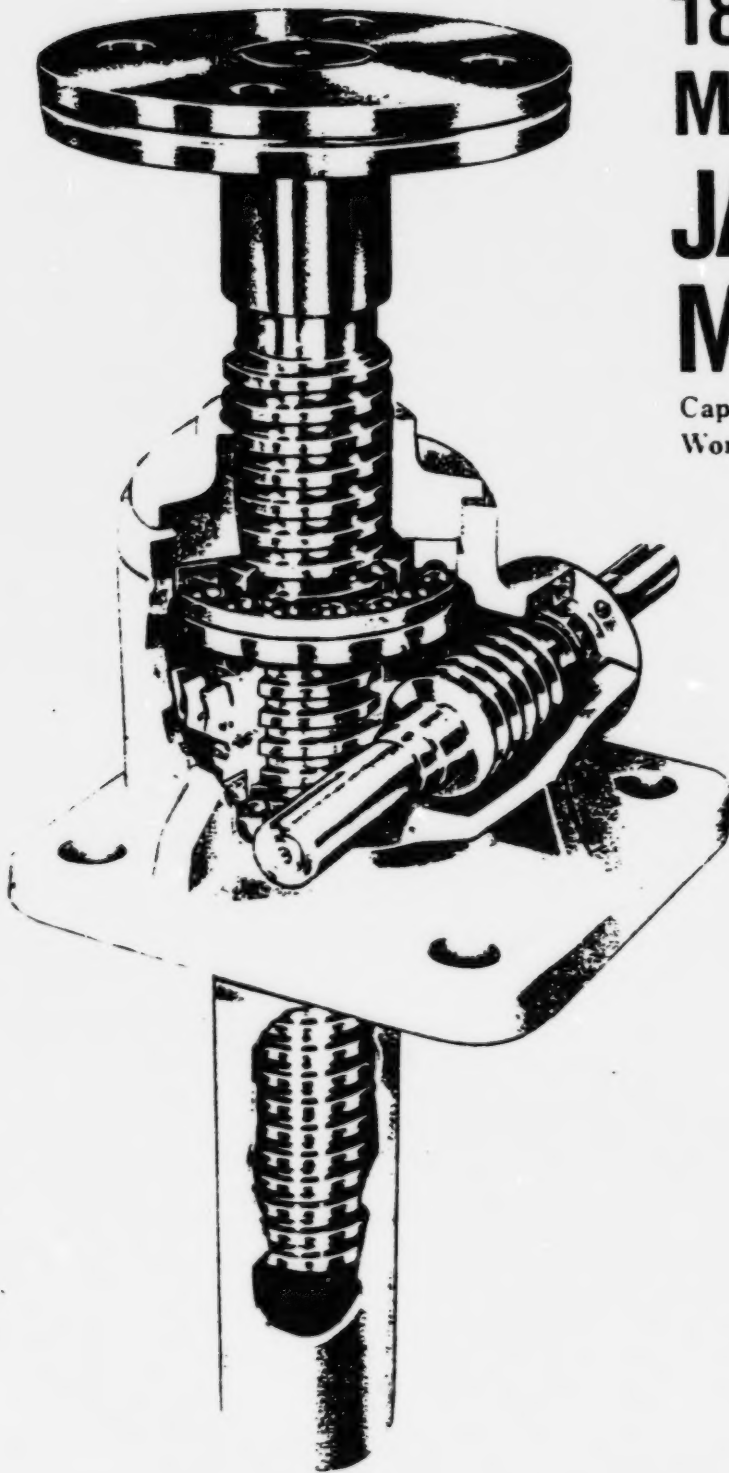
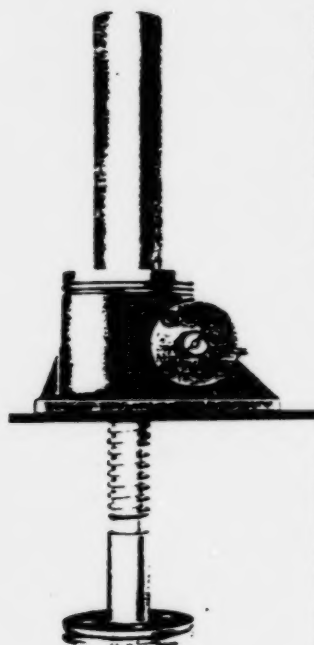


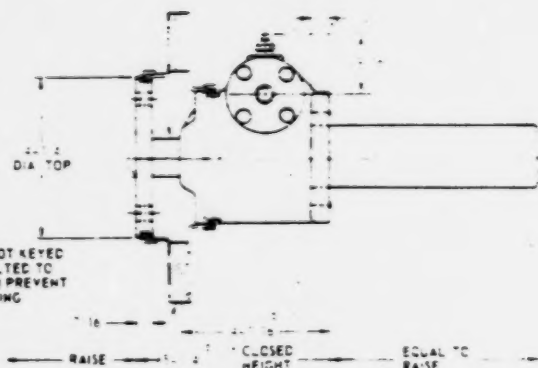
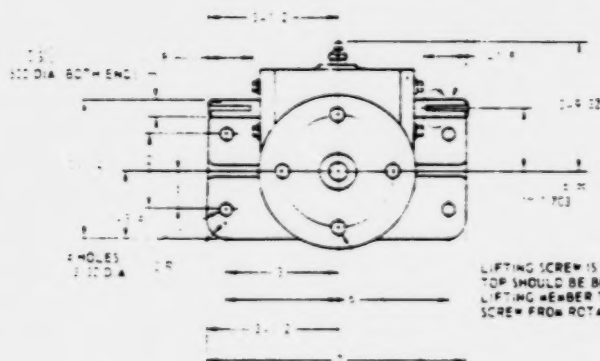
Figure 10 - Jactuator



JACK IS EQUIPPED WITH ALUMINUM GREASE FITTINGS

ALLOY STEEL WORM WITH 1/8" 1/16" X 1/16" KEYWAY BOTH ENDS AVAILABLE WITH EITHER R.H. OR L.H. EXTENSION WORM IS EQUIPPED WITH OIL SEALS AND BEARINGS COUNTERCLOCKWISE ROTATION RAISES LOAD

LIFTING SCREW 1/2" DIA. ACME THD 250 PITCH R.H. SINGLE



LIFTING SCREW IS NOT KEYS TOP SHOULD BE BOLTED TO LIFTING MEMBER TO PREVENT SCREW FROM ROTATING

FOUR HOLES - 13/32 DIA. EQUALLY SPACED ON 3" B.C.

FLEXIBLE BOOT (OPTIONAL) 7-3/4" O.D. X 4-1/2" I.D.

STANDARD RAISES FROM 1" THRU 24" IN 1" INCREMENTS OTHER RAISES AVAILABLE ON REQUEST

IF BELLOWS BOOT IS REQUIRED FOR RAISES EXCEEDING 18" CLOSED HEIGHT OF JACK MUST INCREASE AS FOLLOWS TO ALLOW FOR EXTRA BOOT MATERIAL 11-8" IN WPM INDICATES A BOOT IS SUPPLIED

WORM GEAR RATIO	TURNS OF WORM FOR 1" RAISE	REMARKS
6:1	24	STD RATIO
12:1	48	
24:1	96	

RAISE	CLOSED HEIGHT
19"-20"	5-3/8"
31"-48"	6-1/8"

MACHINE SCREW JACTUATOR MODEL 1802

RATED 2 TONS

Note: Dimensions are subject to change without notice.

Figure 11 - Jactuators Diagram

POOR

QUALITY

ORIGINAL